STEP 2. DESCRIBING THE SITUATION

Existing Road System

Current roads management guidelines for the District are contained in the Carson National Forest Plan (USFS 1986) and amendments. Forest Plan Amendment 9, February 1993, addressed travel management, elements of which include:

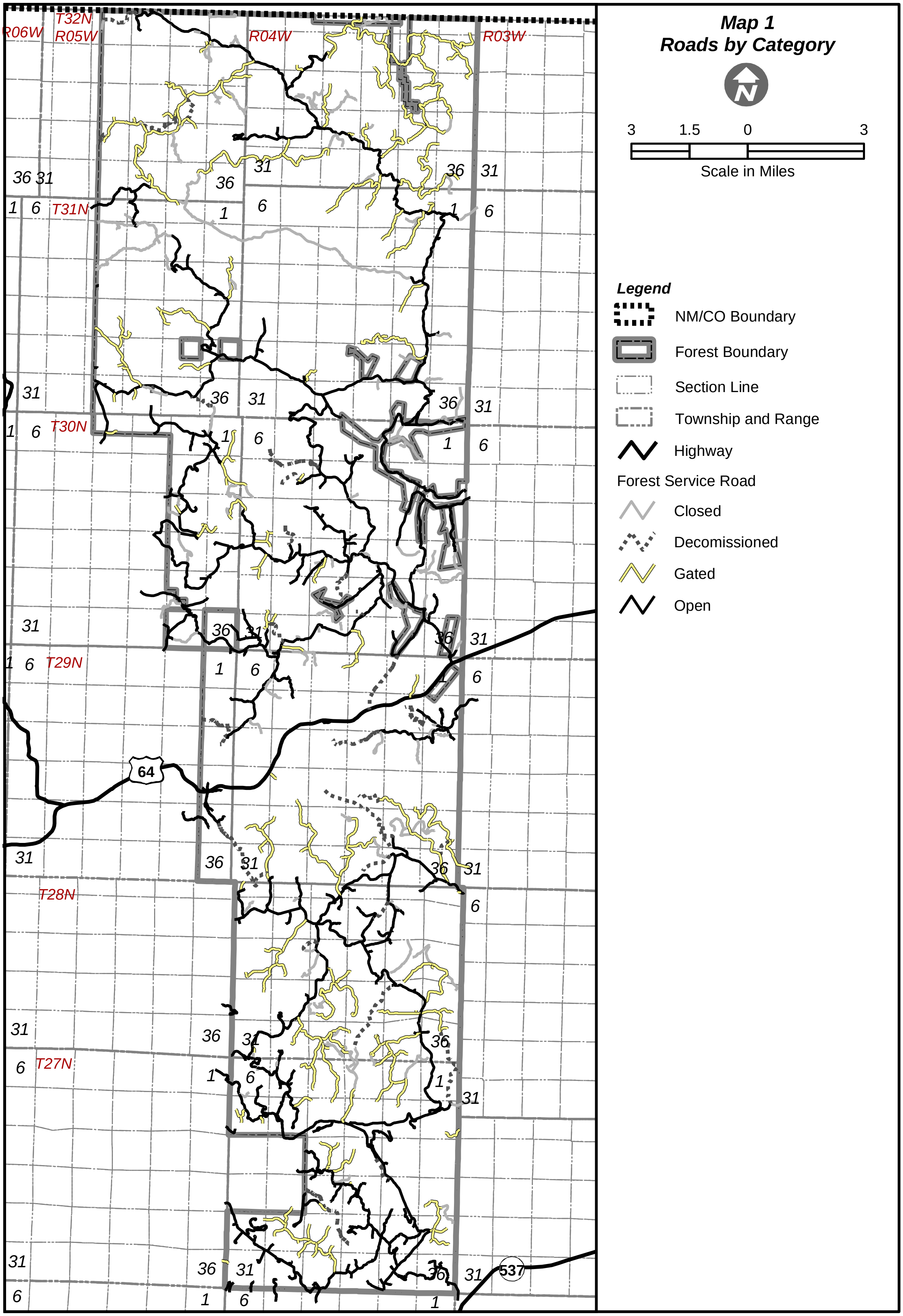
- Restriction of motor travel District-wide with designated open areas when opportunities occur.
- Investigation of a right-of-way for public motorized access for the Colorado/Carracas area.
- Closure of unneeded roads, as defined by a project file (dated 6/11/91).
- Availability of segments of roads to persons with permits, such as owners or lessees of land and/or federal, state, or local officers in the performance of their official duties.
- Increased secure wildlife habitat. The density of roads that are open is not to exceed 1 mile per square mile (mi/mi^2) forest-wide and 0.5 mi/mi^2 in wintering big game habitat.

There are a total of 464 miles of roads on the District, shown on **Map 1**. **Table 1** lists the miles of road in each category, open, gated, closed, and decommissioned. Only roads identified as open are available for public use. Gated roads are accessible only by Forest Service staff and gas industry service vehicles. All roads are unpaved and most consist of bare, compacted soil. A few roads are lined with crushed stone on the surface, in most cases sandstone excavated from small pits near the roads. Most of the roads have culverts installed at stream or arroyo crossings, generally using a culvert size that is readily available, not one that has been engineered to carry the flows from the upstream watershed.

Table 1. Road Mileage by Category

Status	Miles
Closed	73 (16%)
Decommissioned	31 (7%)
Gated	134 (29%)
Open	226 (49%)
All Roads	464 (100%)

The Forest Service has responsibility for the maintenance of 13 miles. The Carson Forest Road Maintenance Committee, composed of gas and oil permittees and the District Ranger, allocate funding for the majority of the road maintenance. The Committee currently allocates approximately $90,000 each year from funds contributed by each permittee to be administered by the District Ranger according to Forest Service standards. The remaining roads are maintained by individual leaseholders on their leases.


Map 1
Roads by Category
N
3 1.5 0 3
Scale in Miles
Legend
NM/CO Boundary
Forest Boundary
Section Line
Township and Range
Highway
Forest Service Road
Closed
Decomissioned
Gated
Open
T32N
T31N
T30N
T29N
T28N
T27N
R06W
R05W
R04W
R03W
64
537

Most of the roads have been constructed to access well pad locations. Gas and oil development in the District began in the 1950s, and the number of active wells have increased since then. Many of the original wells are still producing and their original roads are still used. Currently within the Jicarilla Ranger District, there are a total of 676 active wells and 139 plugged and abandoned wells. Any roads that are not needed to serve oil and gas operations are evaluated by the Forest Service staff to determine whether they should be closed.

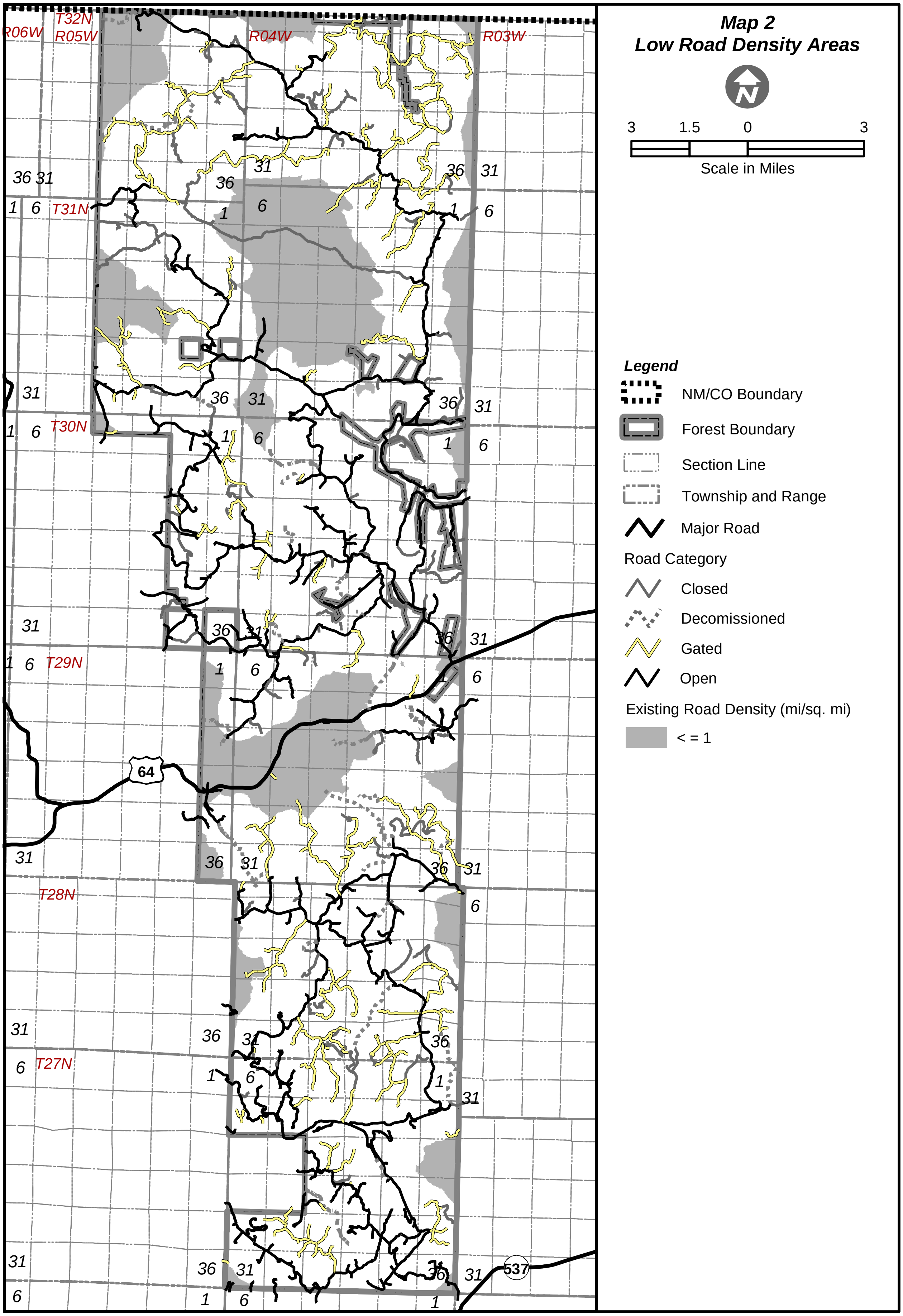
Traffic volumes vary in the District by the time of year. During the drilling season, April 1 through October 31, the main collector roads such as Forest Service 310, 314, and 357 have an estimated 30 to 75 vehicles per day. Other open roads used by industry such as 218, 309, 311, and 312 have an estimated 10 to 35 vehicles per day. The short, gated roads that serve well pads generally have 1 to 2 vehicles per day. During the primary hunting season (October and November), traffic on the major collector roads increases by up to 50 percent. It is estimated that Forest Roads 310 and 218 have the highest traffic levels during the hunting season, averaging 50 vehicles a day. In the winter (December through March), timing limitations restrict gas development operations so only service and maintenance vehicle traffic occurs, resulting in a reduction in industry traffic by about one-third to one-half.

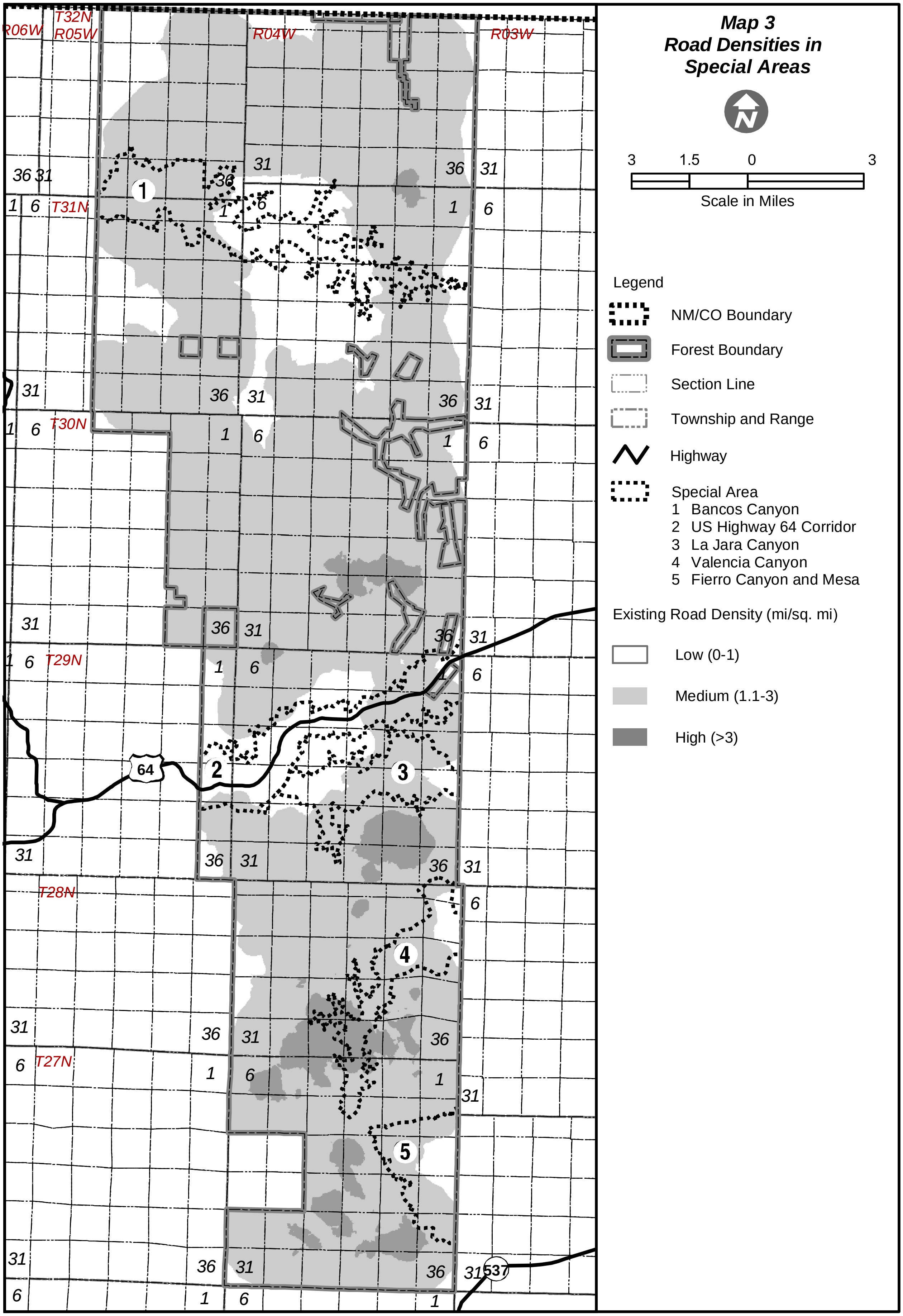
Road density (open and gated roads combined) ranges from 1.6 to 2.6 mi/mi^2 when evaluated by each of the 5th-level watersheds on the District. The Forest Plan limits open road density within the Deer and Elk Winter Range areas to 0.5 mi/mi^2. Current open road density in these areas is 0.6 and 1.1 mi/mi^2, respectively, exceeding the Forest Plan standard. Road density averaged over the entire District is approximately 2.5 mi/mi^2, when considering all roads. The road density of open roads, averaged over the District, is just over 1 mi/mi^2. There are approximately 40 square miles (shown on **Map 2** as shaded sections) that contain less than 1 mi/mi^2 of road, but these are spread throughout the District. The areas with the lowest road density occur within Bancos, La Jara, and Valencia Canyons, and in Fierro Canyon and Mesa (**Map 3**).

Description of the Analysis Area

Geology. The Jicarilla Ranger District of the Carson National Forest is located in the northeastern part of the San Juan Basin. The San Juan Basin is an asymmetrical syncline that extends from northwestern New Mexico into southwestern Colorado. Roughly circular in shape, it is approximately 200 miles long (north to south) and 130 miles wide, including its Colorado portion. The Basin covers approximately 15 to 25,000 square miles (**Figure 1**).

The San Juan Basin is an asymmetrical layering of sedimentary rocks that range in age from Cambrian to Quaternary, underlain by Precambrian rocks. The stratigraphy of the Basin resulted from inundation by epicontinental seas between periods of major uplift. Depositional environments of the various rock units include deep marine, shoreline, continental, and fluvial. Cretaceous formations were downwarped into the Basin during the late Cretaceous until the early Tertiary Laramide tectonic event. By the end of the Laramide uplift, Cretaceous rocks reached their maximum depth of burial, and the Basin achieved it current structural configuration. Subsequent regional heating enhanced the thermal maturation of deeply buried organic matter to a level that generated gas in the center of the Basin and oil at the Basin margins. Basement rock outcrops, including the eroded cores of the Zuni, Jemez, and Sangre de Cristo uplifts, form the edge of the Basin to the east. The Basin is bordered on the northeast by the Archuleta Anticlinorium and on the east by the Nacimiento uplift (BLM 2000). Despite the presence of anticlinal structures on the margins of the Basin, hydrocarbons developed in stratigraphic traps. Formations dip gently to a low point in the northeastern part of the San Juan Basin (Engler et al. 2001).


Map 2
Low Road Density Areas
N
3 1.5 0 3
Scale in Miles
Legend
NM/CO Boundary
Forest Boundary
Section Line
Township and Range
Major Road
Road Category
Closed
Decomissioned
Gated
Open
Existing Road Density (mi/sq. mi)
< = 1
T32N
R06W
R05W
R04W
R03W
T31N
T30N
T29N
T28N
T27N
64
537


Map 3
Road Densities in Special Areas
3 1.5 0 3
Scale in Miles
Legend
NM/CO Boundary
Forest Boundary
Section Line
Township and Range
Highway
Special Area
1 Bancos Canyon
2 US Highway 64 Corridor
3 La Jara Canyon
4 Valencia Canyon
5 Fierro Canyon and Mesa
Existing Road Density (mi/sq. mi)
Low (0-1)
Medium (1.1-3)
High (>3)
T32N
R06W
R05W
R04W
R03W
T31N
T30N
T29N
T28N
T27N
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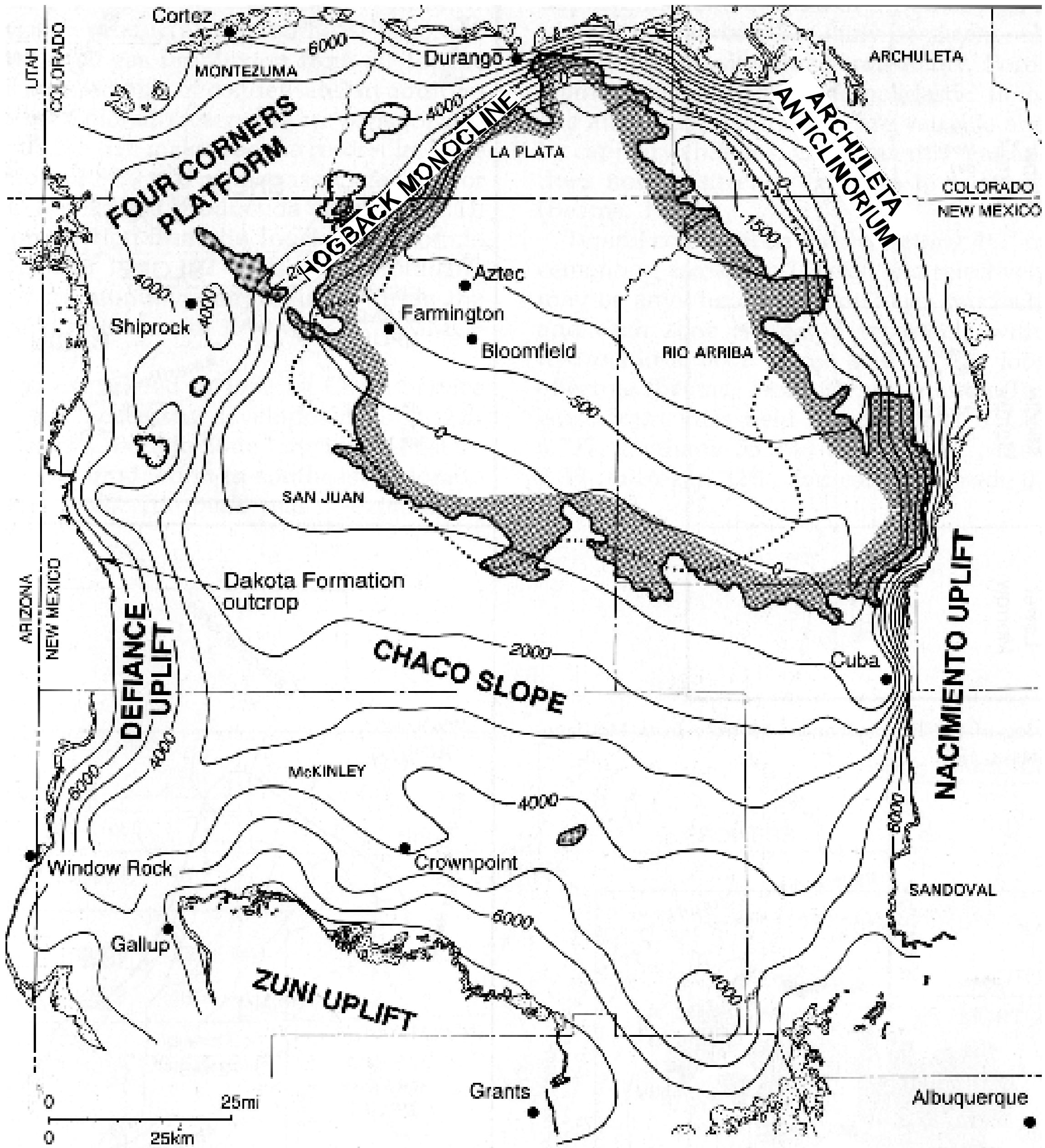

Figure 1. Plan View of the San Juan Basin Showing Structural Features

Source: RFDS 2001.

The lithology of the San Juan Basin includes mainly shales and sandstones of varying grain size but also includes coals, some carbonates, and igneous rocks. Sedimentary rocks display an aggregate thickness of over 14,000 feet near the Colorado-New Mexico state line. The elevation of the top of the Precambrian basement rocks is more than 7,500 feet below sea level at the deepest part of the Basin. Formations representing the Permian period through the Pennsylvanian period consist mainly of shales and sandstones. The Cretaceous-age rocks represent 6,000 feet of sandstones, siltstones, shales, and coals (Landes 1970) shown in **Figure 2**. The Cretaceous formations are gas-bearing reservoirs, some of which are produced from wells in the District.

Era	System		Formation	Thickness	Production
CENOZOIC	TERTIARY		San Jose Formation	2500 ft.	Gas
			Nacimiento Formation	500-1300 ft.	Gas
			Ojo Alamo Sandstone	250 ft.	Gas
MESOZOIC	CRETACEOUS		Kirtland Shale / Farmington Sandstone	1500 ft.	Gas/Oil
			Fruitland Formation	500 ft.	Gas
			Pictured Cliffs Sandstone	250 ft.	Gas
			Lewis Shale / Huerfanito Bentonite	500-1900 ft.	Gas
		Mesaverde Group	Cliff House Sandstone	0-800 ft.	Gas
			Menefee Formation	350-2200 ft.	Gas
			Point Lookout Formation	100-300 ft.	Gas
		Mancos Shale	Upper Mancos Shale/Tocito Sandstone	2300-2500 ft.	Gas/Oil
			Gallup Sandstone/Carlile Shale		Gas/Oil
			Greenhorn Limestone		
			Graneros Shale		
			Dakota Sandstone	150-200 ft.	Gas/Oil
	JURASSIC		Morrison Formation	400-900 ft.	
			Wanakah Formation / Todilto Limestone	50-200 ft.	
			Entrada Sandstone	100-300 ft.	Oil
	TRIASSIC		Chinle Formation	500-1600 ft.	
PALEOZOIC	PERMIAN		Cutler Formation	1500-2500 ft.	
	PENNSYLVANIAN	Hermosa Formation	Honaker Trail Formation		
			Paradox Formation	200-3000 ft.	Gas?
			Pinkerton Trail Formation		
			Molas Formation	0-100 ft.	
	MISSISSIPPIAN		Leadville Limestone	0-165 ft.	
	DEVONIAN		Elbert Formation	0-325 ft.	
	CAMBRIAN		Ignacio Quartzite	0-100 ft.	
			PRECAMBRIAN		

Figure 2. Geologic Time Column of the San Juan Basin

Source: RFDS 2001.

The surficial geology of the San Juan Basin in the area of the District consists primarily of Tertiary alluvium (unconsolidated silts, sands, clays, and gravels) underlain by the pink-tinted San Jose formation (layers of arkosic sandstone, siltstone, shale, and conglomerate). During the formation of the Basin, canyons were created in the area as the southern tip of the Rocky Mountains and the San Juan Mountains to the north rose. Tertiary sediments are exposed in the canyons that trend northwest toward the San Juan River. In areas where it is exposed, the San Jose formation erodes as irregular ledges and slopes. In some places, the San Jose formation erodes into mushroom-shaped rocks, largely the work of wind and wind-driven rain (Chronic 1987). There are no locatable minerals in the District. There are, however, some sandstone pits that support road construction and maintenance. Occasionally, the District receives a request for the collection of rocks for personal use.

Hydrocarbon production in the District consists primarily of natural gas production. The predominant hydrocarbon-producing reservoirs are the Cretaceous Pictured Cliffs, Mesaverde Group, and Dakota formations. They contain both source rocks and natural reservoirs for oil and gas. Slow decomposition of plant and animal material within the source rocks resulted in hydrocarbon deposits.

The Pictured Cliffs Sandstone is a gas reservoir consisting of a shoreline sandstone composed of an upper medium to thick-bedded ledge-forming sandstone and a lower thick, very fine-grained sandstone with interbedded shales and siltstone. The Pictured Cliffs produces natural gas from wells spaced at 160 acres per well. The Mesaverde Group is a series of gas reservoirs that represents a single regression and transgression cycle of the epicontinental Cretaceous sea. These are not blanket sands but are discontinuous shoreline deposits. The main gas-producing sandstones are the Cliff House at the top of the group and the Point Lookout at the bottom. The Mesaverde Group produces natural gas from wells spaced at 320 acres per well, with optional infill development allowed on an 80-acre per well basis.

The Dakota Sandstone is a gas reservoir consisting of a transgressive sequence composed of sandstone, shale, minor conglomerates, and coal. The upper sandstones in the Dakota represent shoreline and offshore marine sand deposits. The Dakota produces natural gas from wells spaced at 160 acres per well. Recent studies indicate that some areas of the Basin, including the southern part of the District, could be approved for 80-acre infill development in the future.

Minerals Management. The Forest Service process approximately 50 applications to drill per year. There are approximately 630 gas wells, with hundreds of miles of associated access roads, pipelines, compressor stations, and other ancillary facilities in the District. The life of a well in the San Juan Basin can extend as long as 50 years.

Hydrocarbon development requires a supporting infrastructure that includes the construction and use of well pads, access roads, pipelines, and the installation of temporary and permanent equipment. Sand and gravel is sometimes used for construction of well pads, compressor stations, roads, and pipelines. Sand and gravel pits are on the Forest Service land where operators may obtain materials with which they maintain their roads. Occasionally, the District has a request for rock collection for personal use. There is usually one pickup per year of rock. The Forest Service Roads Committee provides oversight over these pits.

Roads may be built in order to move a drill rig and well-service equipment from one site to another and to allow access to each site. Bulldozers, graders, and other types of heavy equipment are used to construct and maintain the road system. Standard cut-and-fill construction techniques are used. The roads are usually ditched on one side. A few roads are surfaced with crushed sandstone and in a few places with crushed limestone. Crushed sandstone tends to break down after use into sand. Sand does not provide sufficient support for heavy equipment transport and frequent vehicle use.

Major roads in the District are normally limited to one main route to serve the leases in a geographic area with a maintained access road to each well. The amount of surface area needed for roads is dependent on topography and loads to be transported over it. Generally, the driving surface of main roads is 20 feet wide and on access roads is 14 feet wide, with total widths of up to 40 feet on main roads and 25 feet on access roads, when considering road ditches, cut slopes, and fill areas. Surface disturbance in excess of 130 feet wide is not unusual in steep terrain where slopes exceed 30 percent. New road construction may increase the slope of natural land surface in some areas resulting in increased volume of runoff and increased sediment delivery. Erosion of roads produces sediment that may be transported by surface water runoff. The amount of sediment produced from road erosion depends upon surfacing material, traffic levels, rainfall, and drainage design. Although the District does not contain perennial streams, sediment can be transported through gullies and arroyos after precipitation events. Road erosion is typically a concern at stream crossings, but roads parallel to streams can also cause sedimentation problems (EPA 2001).

Natural gas pipelines (gathering or flow lines) transport gas from the wells to a trunk line, which connects to the main transmission line from the area. Flow lines vary from 2 to 4 inches in diameter and are usually buried. They are typically constructed close to a well's access road within the road ROW. Often the road is used as the working area to install the pipeline, in order to minimize the acreage of surface disturbance, but occasionally pipelines are routed cross-country. Building a gathering line on Forest Service land requires an approved Special Use permit.